NWS Science and Technology Roadmap

IT Segment Architecture

Team Composition

- Harry Tabak, NWS/OCIO—Co-Team Leader
- Chung Wu, NWS/OST/SEC—Co-Team Leader
- Gustavo Limon, NWS/OCIO—Co-Team Leader
- Craig Hegemann, NWS/OCIO1—Contributor
- Ben Kyger, NWS/NCEP—Contributor
- James Lane, NWS/OST/SEC-Contributor
- Maria Sims, NWS/OCIO – Contributor

Vision/Benefits/Impacts

- **IT Architecture Area Team Vision:**
  - Enable NWS to offer mission products and services in a net-centric environment using an agile IT architecture that aligns with its scientific and operational needs and provides enterprise data management and information security that reduces loss of life and property.
- **Benefits**
  - Agile and scalable computation, storage, and network services.
  - Mobile IT Systems for on-site coverage for major events and COOP.
  - Availability of information for on-site decision support meteorologists, emergency managers, users in the government and commerce, and private citizens.
  - Improved reliability at reduced overall costs.
  - Protection of information availability, integrity, and confidentiality.
  - Consistent and searchable information repositories.
- **Impacts:**
  - Rapid provisioning and deployment of services.
  - On-demand scalability and elasticity for new services and capabilities.
  - Improved lower cost disaster recovery capability.
  - Service oriented business model
  - Greater access to data and services for citizens.
  - Net-centric collaboration with citizens, government, and industry.

Goals/Targets:
Customer Needs

Goal	Outstanding Issues
Agile provisioning of IT computational power, storage, and networking.	Generalized utility computing centers vs. specialized and or localized data centers. Centralization vs. 6-8 distributed centers. On demand power vs. guaranteed capacity. Limited time to implement new services. Concern for costs, security, quality of mission critical service delivery.
Improved internal and external customer collaboration	Need for identity management and access control. Limited information availability. Need for collaboration tools. Minimize need for forecaster action in public interface. Net-centricity.
Fully consistent information across the enterprise	Consolidating myriad redundant databases, including localizations, and archive facilities into a master database management system. Need to identify single authoritative sources

Goals/Targets:
Customer Needs

Goal	Outstanding Issues
Reduction of costs: IT administration, management, and security (i.e. C&A, patching, upgrades, licenses, spares).	No cross-cutting IT infrastructure architecture segment separate from core mission science functions (segment). Delivery quality.
Facilitation of agile customer-focused decision support services	Need to adopt/adapt net-centricity: Service Oriented Architecture, Web Services, Master data management, Data Exchange Standards, Ontology based, searchable product directories. Adapt legacy products.
Successful mobile IT Systems for on-site coverage of major events & COOP	No Master Data Base. Remote and secure access to computing and data resources.
Comprehensive Science & Tech Infusion test facilities	Lack of ability to model real world as a virtual environment. Use of virtual servers, virtual networks, and replication of Master DB data.
Continuity of Operations (COOP) and Critical Infrastructure Protection (CIP)	Need for seamless shifting processes and information to alternate sites. Network collection of sensor information (I.e. ASOS)
Clear path for new technology infusion	Limited alignment with enterprise life cycle, CPIC, PPBES, and OSIP processes

Goals/Targets:
Emerging Science & Technology

Goal/Target	Outstanding Issues
Agile IT provides computation, storage, and networking on demand as easy as turning on the tap. The right information to the right people at the right time.	Degraded reliability and quality for mission. Shifting responsibility of IT management from vertical functional domains to a single horizontal cross-cutting domain.
Virtual Servers used to achieve Site/office hardware independent applications	Need to set architectural standards; use in service backup & testing; configuration management requirements; Archiving Virtual Servers.
Master Data Management -- Consolidate all enterprise databases – forecast, real time, localizations, and archival --into one distributed system with single authoritative source	Lack of reliability and quality for mission. Shifting responsibility of data management from vertical functional domains to single horizontal cross cutting domain
Expanded capacity of existing infrastructure to handle data intensive demands.	Need to adapt activities for geospatial routing, WAN acceleration, data “pull” or subscription rather than traditional “pull.”

Goals/Targets:
Emerging Science & Technology

Goal/Target	Outstanding Issues
Net-centricity and Service Oriented Architecture with enterprise service bus: web services, data services, collaborative services, map displays, GIS services.	New way of thinking about mission products and working with customers. Areas-- Presentation: Product dissemination, Automatic Web content, Web Services; Product assembly: Combinable service modules for mash-ups.
Full information security in the pervasive access environment of universal networking – the right access to right data for the right people.	Identifying and registering employees, emergency workers, public, etc (Identity Management). Role models, Directories, Linking to partner directories. Data sensitivity labeling. Industry and government document security standards.
Established data exchange standards	Identifying and adopting evolving standards for information sharing, Customer usability, information searching.

Key Information Gaps

Gap	Solution Alternative	Impact
1 Lack of commonality in infrastructure.	1.1 'Cloud computing' to consolidate commodity IT infrastructure. Cloud computing is a pay-per-use model for enabling available, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. Solution includes use of virtual servers, and virtual networks. Processing vortexes can be configured to bring processing and data storage in close proximity for efficiency.	• Agile provisioning of IT. Increased capacity for Roadmap needs. Lower costs through economies of scale. Reduced IT administration, hardware, software & security costs . I.e. C&A, patching, licensing, spares, tech refresh. • Supports Mobile IT Systems, Science & Tech Infusion test facilities, research test facilities, network collection of sensor information, COOP and CIP. • Services are ordered to meet specifications. Reduces costs for spare event capacity, disaster recovery costs. • Suitable for dynamic surges in load. • Requires re-architecting much of NWS IT including Web, AWIPS II, MADIS, NWSTG, NCEP, WFO/RFC.

Key Information Gaps

Gap	Solution Alternative	Impact
2 Lack of enterprise data management	2.1 Master Data Management (MDM) architecture based on semantic geospatial 4D mapping. Includes data, data exchange, and metadata standards; ontology based data set linking; and searchable catalogues or registries. Combines data from multiple sources into a single authoritative source (SAS) Manages observations, model output, locally tailored, archive, and LFWW. Also business and IT configuration.	• Single authoritative source data for operations. • Simplifies disaster recovery and COOP. • Consistent, searchable, and semantically linked information across the enterprise for internal and external customer collaboration. • Facilitate agile customer focused decision support services; Mobile IT Systems; research and test facilities. • Reduced service development costs and increased agility. Allow local products go national; recovery of operations. Locate data sources for new products or ad hoc products.

Key Information Gaps

Gap	Solution Alternative	Impact
3 Lack of Information Protection in Pervasive Access Environment	3.1 Pervasive Access Security. Focus on user identification and authorization, role based access control, and data authentication (data branding or signing) issues. Includes use Federal HSPD-12 IDs, and links to partner user registries, industry document security standards.	NOAA information is subject to pervasive access through networks for workers, users, partners, and foes. Cloud computing, MDM, and SOA require to ensure to ensure that the right info is available to the right people at the right time.

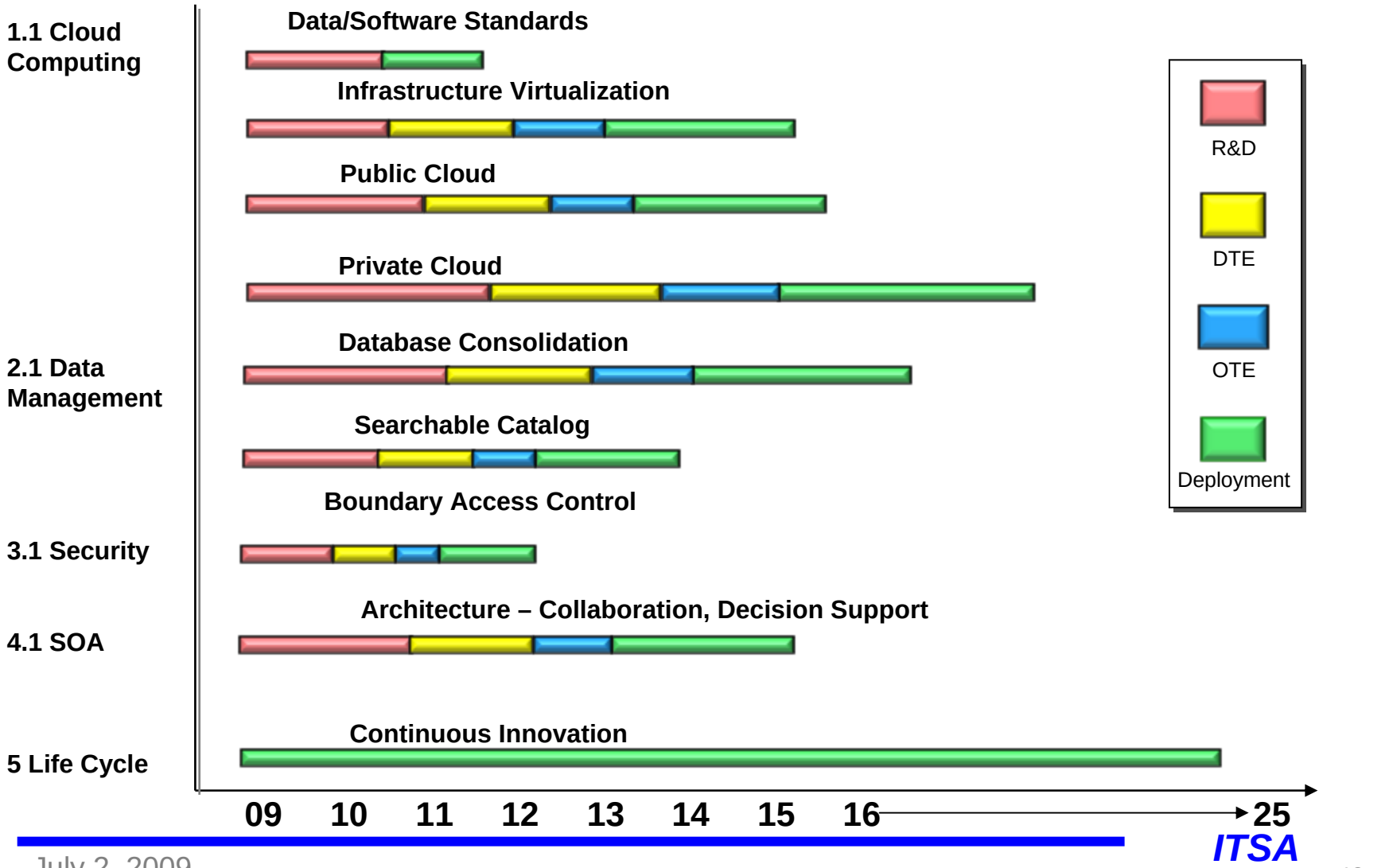
Key Information Gaps

Gap	Solution Alternative	Impact
4 Need for Agile Decision Support Services	4.1 Service Oriented Architecture with mash-ups, Web Services for data exchange, ESB for legacy systems. SOA provides portal for both internal and external access to full set of services. Relies on services provided by alternate solution 1.1 through 4.1	• Radical change of perspective from product publishing to service provision. Customer interaction, new service combinations from existing services. • SOA is a best practice for Federal architecture alignment. • AWIPS II is pioneering SOA

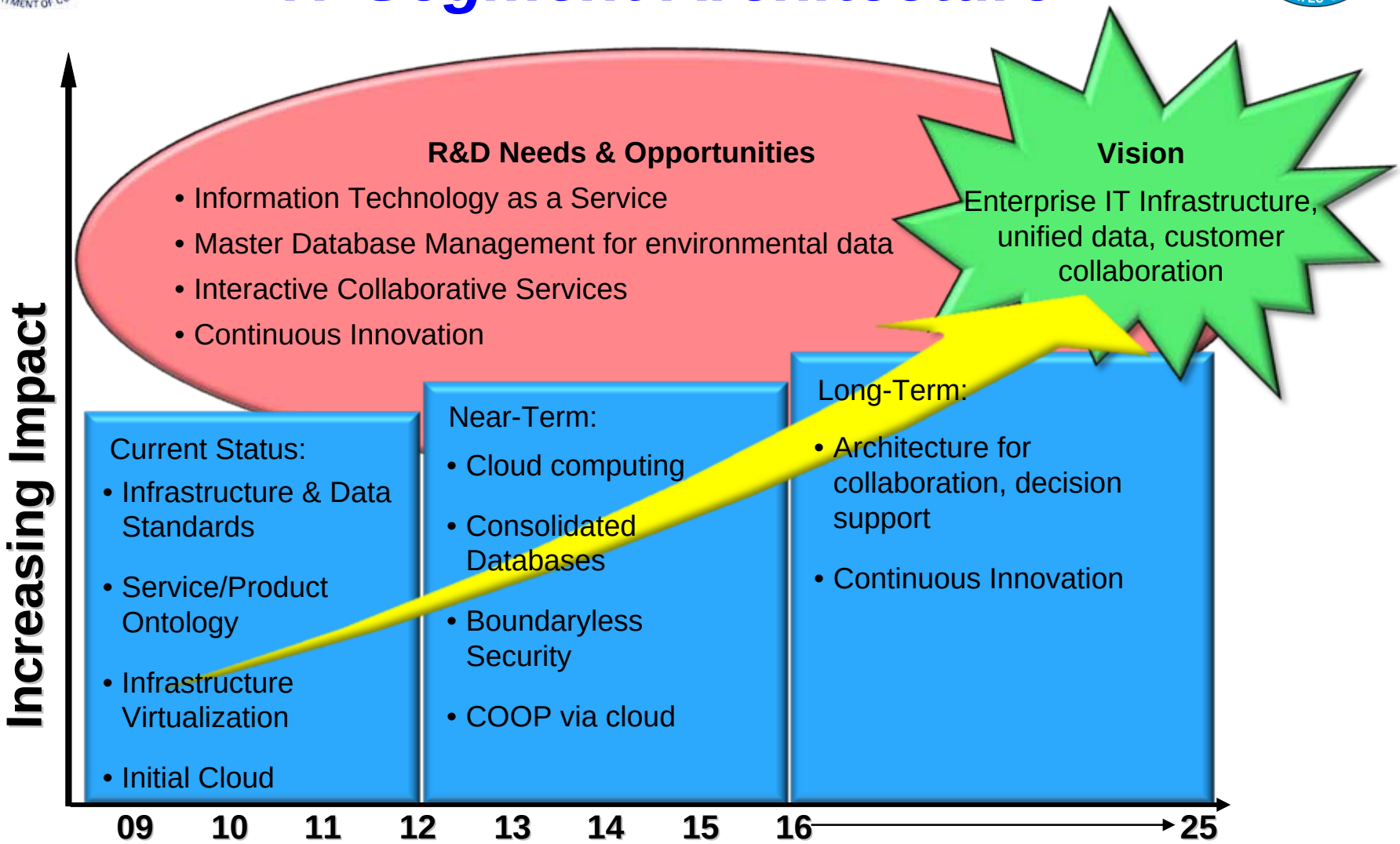
Research Needs and Opportunities

- **Short-term**
  - Cloud computing: Mission requirements suitability, performance, quality, availability, security, COOP, cost, and legacy system conversion. Operating system and network virtualization issues.
  - Study requirements and architectures for Master Data Management to meet mission requirements: geospatial mapping, semantic relationships, single authoritative source, performance, quality, availability, COOP, and cost.
  - Metadata, taxonomies, and ontologies for cataloging and categorizing service, data and product descriptions. NWS and academic ontology research is ongoing.
  - Net-centric or Web 2.0 technologies for interaction and collaboration with customers and partners.
- **Long-term**
  - Continue short term Cloud thrust : More advanced approaches. Focus on mission software as a service.
  - Track technology innovations for improved infrastructure efficiencies and for new and better ways to interact with customers and partners

ITSA Alternative Solutions



Focus Area Team Summary: IT Segment Architecture



NWS Science and Technology Roadmap

IT Segment Architecture Team Additional Information

Steps to get there Cloud Computing

Step	Priority
Research and adopt standards, architecture (patterns), and governance	**1**
Develop Security Model	**1**
Server Virtualization	**2**
Public Cloud	
Public Web	**4**
FTP, file servers	**4**
Citizen Engagement	**4**
Productivity/Office Automation	**3**
Private Cloud	
New Projects	**2**
AWIPS Infrastructure/Platforms	**5**
WFO/RFC, National Centers Infrastructure/Platforms	**6**
Gateway Infrastructure/Platforms	**7**
COOP/Disaster Recovery/ remote backup capabilities	
Core Mission as services	**8**
Network Virtualization	**9**

Steps to Get There
Master Data Management

Step	Priority
Research and adopt standards, architecture (patterns), and governance.	1
Develop MDM architecture for geospatial 4D semantic relationship	2
WMO Registry	3
Next Gen	
Incorporate new data sources, projects	4
Incorporate NDFD (incl localizations)	5
IRIS and other Databases	6
IT Configurations	7
Business Data	8

Steps to Get There
Security

Step	Priority
Research and adopt standards, architecture (patterns), and governance.	**1**
Data Authentication – Branding or signing data	**2**
User Identification	
Internal users	**3**
External users	**4**
Role-based access controls	
Data tagging	**3**
Authorization procedures	**3**
Boundary Access Control	**2**

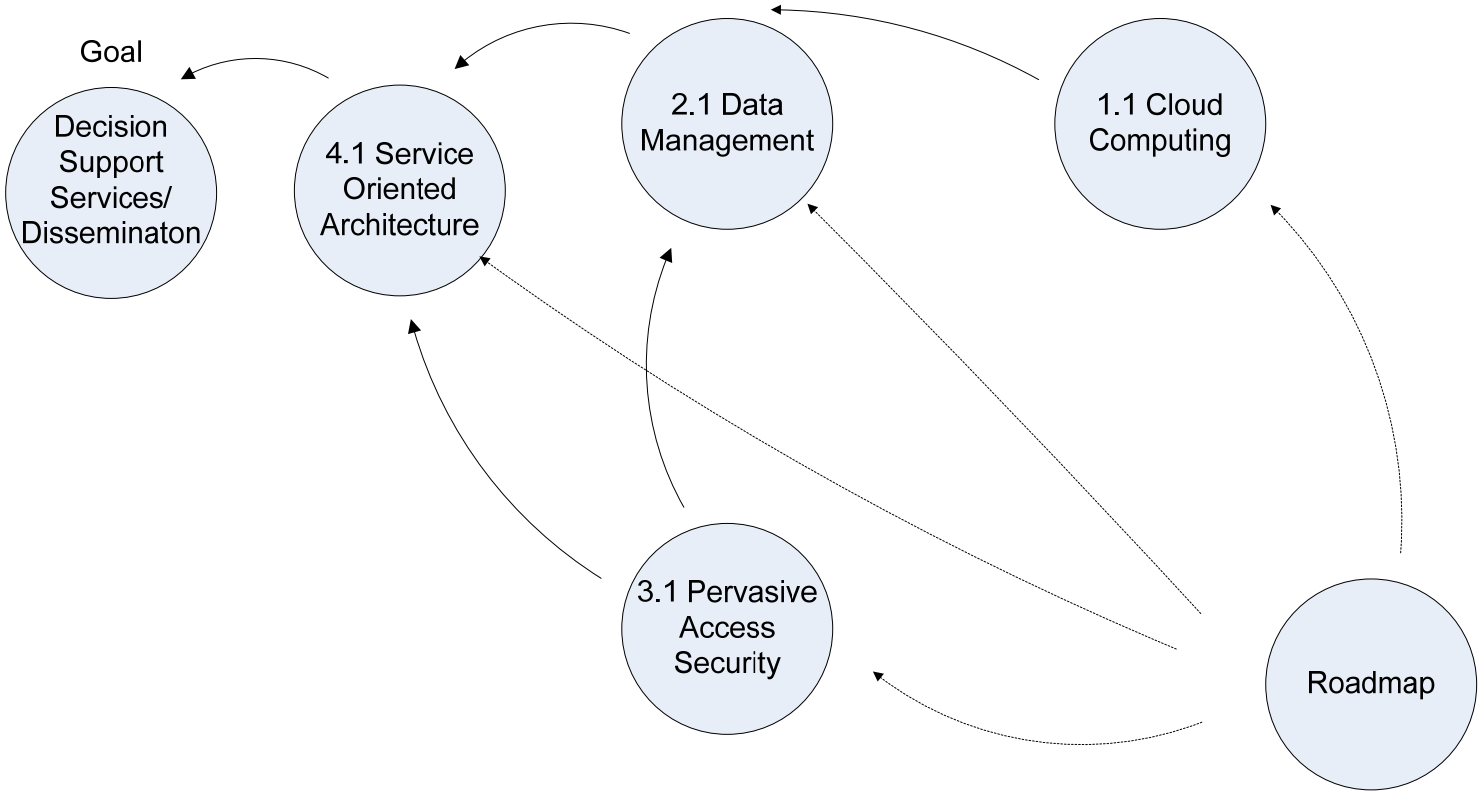
Steps to get there
Service Oriented Architecture

Step	Priority
Research and adopt standards, architecture (patterns), and governance. Lessons learned from AWIPS II	1
Service/Data registry (tied to MDM Registry)	3
Links to external supplied services	6
New Projects	4
Convert Legacy Products to Services	5

Target Performance Measures: IT Segment Architecture

Proposed	Current (2009)	FY 16 Target Example	FY 25 Target Example
Adopt Virtual Platforms	No Activity	All applications run on virtual OSes	
Adopt and implement common data, security, and protocol standards	None	All systems	
Public Cloud	No Activity	Weather.gov	All internet capable dissemination services and citizen engagement
Private Cloud	No Activity	AWIPS, New projects	All Data Centers
Master Database Management	None	Observations, Model Output, NDFD	All databases
Service/Data registry	Start WMO pilot	Major products and data sets	All products and data sets
Support Decision Support Service (DSS)	Tier 5 and 4	Tier 5, 4, and 3	Tier 5, 4, 3, 2, and 1
COOP/CIP remote backup capabilities	Mission-critical systems	AWIPS, New Projects	All Data Centers
Boundary Access Control	Internal users	Partners	External Users
SOA for collaboration and decision support	AWIPS II in development	Major Services	All services

Solution Dependencies



Administration Priorities for Infrastructure Modernization and Cloud Computing

"The Federal technology environment requires a fundamental reexamination of investments in technology infrastructure."

"The Infrastructure Modernization Program will be taking on new challenges and responsibilities. Pilot projects will be implemented to offer an opportunity to utilize more fully and broadly departmental and agency architectures to identify enterprise-wide common services and solutions with a new emphasis on cloud computing. "

"The Federal Government will transform its Information Technology Infrastructure by virtualizing data centers, consolidating data centers and operations, and ultimately adopting a cloud-computing business model."

FY2010 Federal Budget
Analytical Perspectives
Cross Cutting Programs
http://www.whitehouse.gov/omb/budget/fy2010/assets/crosscutting.pdf

Cloud Computing Definition

"*Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is composed of five essential characteristics, three delivery models, and four deployment models*".

NIST

Definition of Cloud Computing, Draft version 14

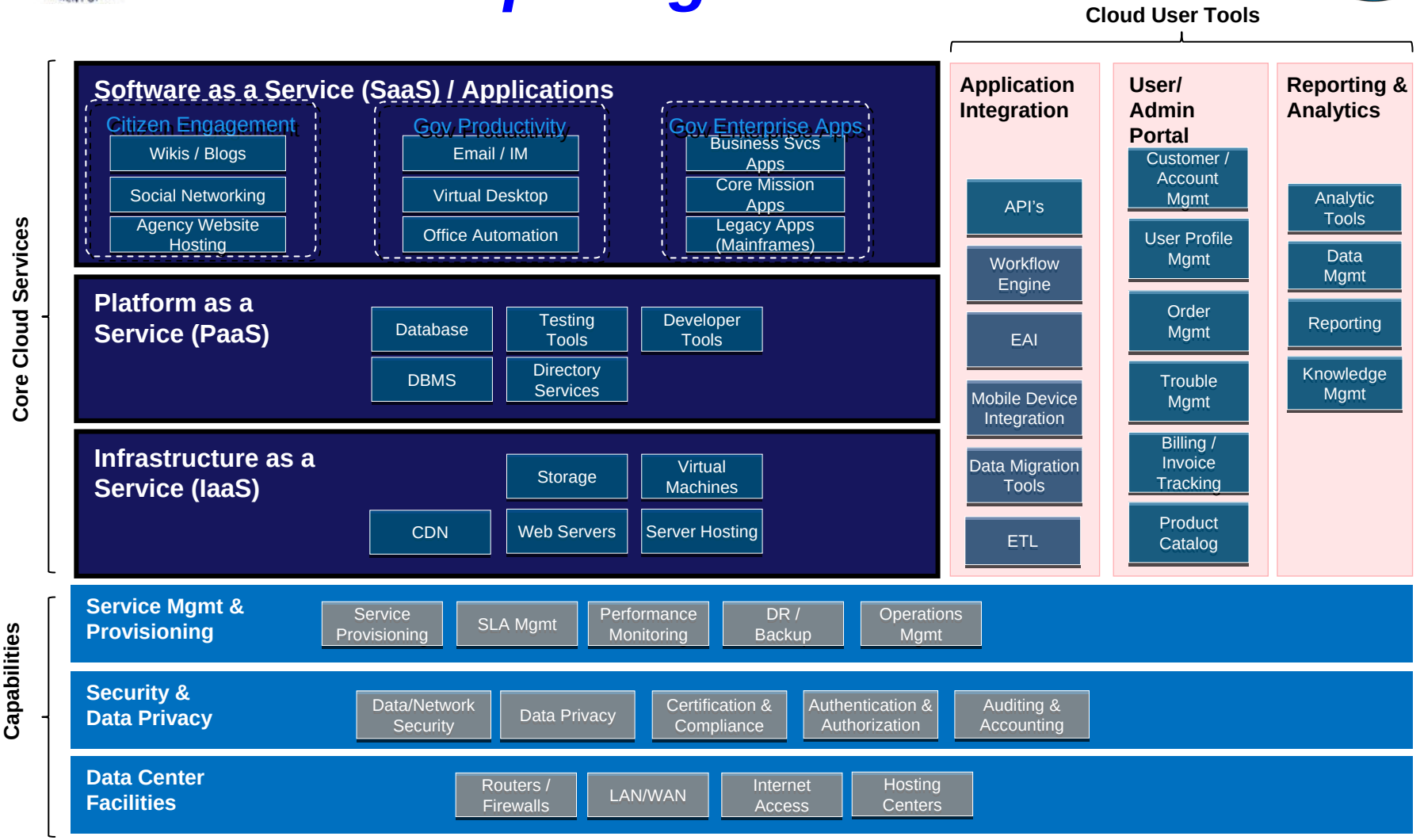
http://csrc.nist.gov/groups/SNS/cloud-computing/index.html

Cloud Computing Defined (continued)

- **Five Characteristics:**
  - **On Demand Service**
  - **Ubiquitous Network Access**
  - **Location Independent Resource Pooling**
  - **Rapid Elasticity**
  - **Measured Service**
- **Delivery Models**
  - **Software as a Service (SaaS)**
  - **Platform as a Service (PaaS)**
  - **Infrastructure as a Service (IaaS)**
- **Deployment Models**
  - **Private Cloud**
  - **Community Cloud**
  - **Public Cloud**
  - **Hybrid Cloud**
- **Cloud computing often leverages**
  - **Massive scale**
  - **Virtualization**
  - **Free software**
  - **Autonomic computing**
  - **Homogeneity**
  - **Geographically distributed systems**
  - **Advanced security technologies**
  - **Service-oriented software**

GSA Federal Cloud Computing Initiative Overview http://www.usaservices.gov/intergovt/documents/StateWebPres6-18.ppt

Government Cloud Computing Framework



GSA Federal Cloud Computing Initiative Overview http://www.usaservices.gov/intergovt/documents/StateWebPres6-18.ppt

Platform Virtualization

- **"[Cloud computing] relies on separating your applications from the underlying infrastructure" - Steve Herrod, CTO at VMware**
- **Host operating system provides an abstraction layer for running virtual guest OSs**
- **Key is the "hypervisor" or "virtual machine monitor"**
  - Enables guest OSs to run in isolation of other OSs
  - Run multiple types of OSs
- **Increases utilization of physical servers**
- **Enables portability of virtual servers between physical servers**
- **Increases security of physical host server**

NIST Peter Mell http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-computing-v22.ppt

Three Features of Mature SaaS Applications

- **Scalable**
  - Handle growing amounts of work in a graceful manner
- **Multi-tenancy**
  - One application instance may be serving hundreds of companies
  - Opposite of multi-instance where each customer is provisioned their own server running one instance
- **Metadata driven configurability**
  - Instead of customizing the application for a customer (requiring code changes), one allows the user to configure the application through metadata

NIST Peter Mell http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-computing-v22.ppt

Web 2.0

- **Is not a standard but an evolution in using the WWW**
- **“Don’t fight the Internet” – CEO Google, Eric Schmidt**
- **Web 2.0 is the trend of using the full potential of the web**
  - Viewing the Internet as a computing platform
  - Running interactive applications through a web browser
  - Leveraging interconnectivity and mobility of devices
  - The “long tail” (profits in selling specialized small market goods)
  - Enhanced effectiveness with greater human participation
- **Tim O'Reilly: “Web 2.0 is the business revolution in the computer industry caused by the move to the Internet as a platform, and an attempt to understand the rules for success on that new platform.”**

NIST Peter Mell http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-computing-v22.ppt

Web Services

- **Self-describing and stateless modules that perform discrete units of work and are available over the network**
- **“Web service providers offer APIs that enable developers to exploit functionality over the Internet, rather than delivering full-blown applications.” - Infoworld**
- **Standards based interfaces (WS-I Basic Profile)**
  - e.g., SOAP, WSDL, WS-Security
  - Enabling state: WS-Transaction, Choreography
  - Many loosely coupled interacting modules form a single logical system (e.g., Legos)

NIST Peter Mell http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-computing-v22.ppt

Service Oriented Architectures

- **Service Oriented Architectures**
  - Model for using web services
    - service requestors, service registry, service providers
  - Use of web services to compose complex, customizable, distributed applications
  - Encapsulate legacy applications
  - Organize stove piped applications into collective integrated services
  - Interoperability and extensibility

NIST Peter Mell http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-computing-v22.ppt

Cost of Traditional Data Centers

- 11.8 million servers in data centers
- Servers are used at only 15% of their capacity
- 800 billion dollars spent yearly on purchasing and maintaining enterprise software
- 80% of enterprise software expenditure is on installation and maintenance of software
- Data centers typically consume up to 100 times more per square foot than a typical office building
- Average power consumption per server quadrupled from 2001 to 2006.
- Number of servers doubled from 2001 to 2006

NIST Peter Mell http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-computing-v22.ppt

Energy Conservation and Data Centers

- **Standard 9000 square foot costs $21.3 million to build with $1 million in electricity costs/year**
- **Data centers consume 1.5% of our Nation's electricity (EPA)**
  - .6% worldwide in 2000 and 1% in 2005
- **Green technologies can reduce energy costs by 50%**
- **IT produces 2% of global carbon dioxide emissions**

NIST Peter Mell http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-computing-v22.ppt

Cloud Economics

- **Estimates vary widely on possible cost savings**
- **“If you move your data centre to a cloud provider, it will cost a tenth of the cost.” – Brian Gammage, Gartner Fellow**
- **Use of cloud applications can reduce costs from 50% to 90% - CTO of Washington, D.C.**
- **IT resource subscription pilot saw 28% cost savings - Alchemy Plus cloud (backing from Microsoft)**
- **Preferred Hotel**
  - Traditional: $210k server refresh and $10k/month
  - Cloud: $10k implementation and $16k/month
- **Using cloud infrastructures saves 18% to 29% before considering that you no longer need to buy for peak capacity - George Reese, founder Valtira and enStratus**

NIST Peter Mell http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-computing-v22.ppt